CHAPTER 6

EROSION AND SEDIMENT CONTROL

Chapter 6 Erosion and Sediment Control
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6.1 Erosion and Sediment Control Guidelines

6.1.1 Background

Erosion and sedimentation are natural, geologic processes whereby soil materials are detached and transported from one location and deposited in another, primarily due to rainfall and runoff. The construction and operation of highway facilities can result in accelerated erosion and sedimentation. This accelerated process can result in significant impacts such as expensive maintenance problems, unsightly conditions, instability of slopes and disruption of ecosystems. For this reason, the design process must give consideration to minimization of erosion and sedimentation.

6.1.2 Federal Policy

As a result of the National Environmental Policy Act of 1969, much attention has been directed to the control of erosion and sedimentation: numerous State and Federal regulations and controls governing land disturbing activities have been developed and published. There are Federal control requirements exerted by numerous agencies (Corps of Engineers, Environmental Protection Agency, Fish and Wildlife Service, etc.) through their administration of various permitting requirements (Section 404, Section 402 and the NPDES Program of the Federal Water Pollution Control Act (FWPCA), and Section 9 and 10 of the River and Harbor Act).

6.1.3 AASHTO Policy

The American Association of State Highway Officials' policy for erosion and sediment control is stated in the publication, "A Policy on Geometric Design of Highways and Streets," as follows.

"Erosion prevention is one of the major factors in design, construction and maintenance of highways. It should be considered early in the location and design stages. Some degree of erosion control can be incorporated into the geometric design, particularly in the cross section elements. Of course, the most direct application of erosion control occurs in drainage design and in the writing of specifications for landscaping and slope planting.

Erosion and maintenance are minimized largely by the use of flat side slopes, rounded and blended with natural terrain; serrated cut slopes; drainage channels designed with due regard to width, depth, slopes, alignment and protective treatment; inlets located and spaced with erosion control in mind; prevention of erosion at culvert outlets; proper facilities for ground water interception; dikes, berms and other protective devices; sedimentation devices to trap sediment at strategic locations; and protective ground covers and planting."

Although some standardization of methods for minimizing soil erosion in highway construction is possible, guidelines for erosion control are of a general nature because of the wide variation in climate, topography, geology, soils, vegetation, water resources and land use encountered in different projects throughout the State.

6.1 Erosion and Sediment Control Guidelines

6.1.4 ADOT Policy

Since highway construction may involve the disturbance of large land areas, control of erosion and sedimentation is a major concern. The following reference is to be consulted for application of the principles and goals presented herein. Erosion and sediment control practices can be subdivided onto temporary and permanent. Temporary controls are those that are used during the construction phase and are presented in the following document:

ADOT Erosion and Pollution Control Manual for Highway Design and Construction

Some permanent controls are presented in Section 6.4.

6.2 Planning for Permanent Erosion And Sediment Control

6.2.1 Introduction

For a permanent erosion and sediment control program to be effective, it must be considered and measures taken in the project planning stage. These planned measures, when conscientiously constructed, will result in orderly development without environmental degradation. The design of erosion and sediment control systems involves the application of common sense planning and design of actions that will minimize the adverse impacts of soil erosion, transport and deposition.

6.2.2 Guidelines

The following basic guidelines govern the development and implementation of a sound permanent erosion and sediment control plan.

- The elements should be planned to take advantage of the topography, soils, waterways and natural vegetation at the site.
- Onsite erosion control measures should be applied to reduce the gross erosion from the site.

These guidelines should be tied together in the planning process, which identifies potential erosion and sediment control problems and control measures before construction begins.

6.2.3 Sediment Control Measures

Control measures are actions that either retard erosion or remove sediment from runoff. Measures to retard erosion include stabilizing surface treatments, vegetation retention, sodding, mulching, and seeding. Measures for removal of sediment include filtration buffers and sediment traps.

6.3 Factors Influencing Erosion

6.3.1 Principal Factors

The inherent erosion potential of any area is determined by four principal factors: soil characteristics, vegetative cover, topography, and climate. Although each of these factors is discussed separately herein, they are interrelated in determining erosion potential.

6.3.2 Soil Characteristics

The properties of soil which influence erosion by rainfall and runoff are ones which affect the infiltration capacity of a soil and those which affect the resistance of a soil to detachment and being carried away by falling or flowing water. Soils containing high percentages of fine sands and silt are normally the most erodible. As the clay and organic matter content of these soils increases, the erodibility decreases. Clays act as a binder to soil particles, thus reducing erodibility. However, while clays have a tendency to resist erosion, once eroded they are easily transported by water. Soils high in organic matter have a more stable structure that improves their permeability. Such soils resist raindrop detachment and infiltrate more rainwater. Clear, well-drained and well-graded gravels and gravel-sand mixtures are usually the least erodible soils. Soils with high infiltration rates and permeabilities reduce the amount of runoff.

6.3.3 Vegetative Cover

Vegetative cover plays an important role in controlling erosion in the following ways:

- shields the soil surface from the impact of falling rain,
- holds soil particles in place,
- maintains the soil's capacity to absorb water,
- slows the velocity of runoff, and
- removes subsurface water between rainfalls through the process of evapotranspiration.

Limiting and staging the removal of existing vegetation and decreasing the area and duration of exposure can significantly reduce soil erosion and sedimentation. Special consideration should be given to the maintenance of existing vegetative cover on areas of high erosion potential such as erodible soils, steep slopes, drainageways and the banks of streams.

6.3.4 Topography

The size, shape and slope characteristics of a watershed influence the amount and rate of runoff. As both slope length and gradient increase, the rate of runoff increases and the potential for erosion is magnified. Slope orientation can also be a factor in determining erosion potential.

6.3 Factors Influencing Erosion (continued)

6.3.5 Climate

The frequency, intensity and duration of rainfall are fundamental factors in determining the amounts of runoff produced in a given area. As both the volume and velocity of runoff increase, the capacity of runoff to detach and transport soil particles also increases. Where storms are frequent, intense or of long duration, erosion risks are high. Seasonal changes in temperature, as well as variations in rainfall, help to define the high erosion risk period of the year. When precipitation falls as snow, no erosion will take place. However, in the spring the melting snow adds to the runoff and erosion hazards are high. Because the ground is still partially frozen, its absorptive capacity is reduced. Frozen soils are relatively erosion-resistant. However, soils with high moisture content are subject to uplift by freezing action, and are usually very easily eroded upon thawing.

6.4 Control Measures And Practices

6.4.1 Introduction

Following is a discussion of the commonly used permanent erosion and sediment control practices with comments regarding application. The **ADOT Erosion and Pollution Control Manual for Highway Design and Construction** shall be used for design detailing and construction guidelines regarding temporary control measures.

6.4.2 Channel Lining

One means of reducing erosion during highway construction and operation is through the use of properly designed linings in drainage channels. Linings may be rigid, such as Portland cement or asphaltic concrete, or flexible, such as vegetation or rock riprap. Flexible linings of erosion resistant vegetation and rock riprap should be used whenever feasible. When vegetation is chosen as the permanent channel lining, it may be established by seeding or sodding. Installation by seeding usually requires protection by one of a variety of temporary lining materials until the vegetation becomes established.

Use Consideration

Flexible linings are generally less expensive to install than rigid linings. They permit infiltration and exfiltration, have a natural appearance, especially after vegetation is established, and provide a filtering media for runoff contaminants. Vegetative and rock riprap liners provide less improvement in conveyance over natural conditions and the resultant acceleration of flow volume and peak is less than with rigid linings.

Flexible linings do have the disadvantage of being limited in the depth of flow that they can accommodate without erosion occurring. As a result, the channel may provide a low capacity for a given cross-sectional area when compared to a rigid lining. Also limited right-of-way, unavailability of rock, or the inability to establish vegetation may preclude the use of flexible linings. In these instances, rigid linings may be the only alternative.

6.4 Control Measures And Practices (continued)

Design Detailing

Rigid Channel Linings - For rigid channel linings, such as concrete or soil cement, there is no maximum permissible depth for the flow velocities normally encountered in highway drainage work, since no erosion can occur. Thus, the maximum flow depth is based only on the freeboard requirement for the channel. See the Bank Protection Chapter for more design detailing related to rigid channel linings

6.4.3 Outlet Protection

The outlets of pipes and structurally lined channels are points of critical erosion potential. To prevent scour at stormwater outlets, a flow transition structure is needed which will absorb the initial impact of the flow and reduce the flow velocity to a level that will not erode the receiving channel or area.

For low flows and low velocities, the most commonly used device for absorption of the impact of flow is a riprap apron. They are constructed at a zero grade for a distance that is related to the outlet flow rate and the tailwater level. See the ADOT Erosion and Pollution Control Manual for additional information. Where the flow force is excessive, structural energy dissipators can be used. See Chapter 11, Energy Dissipator for additional information regarding energy dissipators.

Design Detailing

Permissible velocity guidelines for grass and earth-lined channels are presented in Chapter 7, Channels for aid in the determination of outlet protection needs.

6.5 Erosion Sediment Control Plan

6.5.1 Control Plan

Depending on the amount of land disturbance that a project will impact, a formal storm water pollution prevention plan (SWPPP) may be required. The **ADOT Erosion and Pollution Control Manual for Highway Design and Construction** shall be consulted for development of the SWPPP. As stated in the above referenced manual "The plan is to identify potential sources of pollution and describe practices that will be implemented to reduce erosion, minimize sedimentation and eliminate non-storm water pollutants for the site." This plan is to be prepared by a Registered Landscape Architect. The drainage designer may need to assist the SWPPP preparer with the collection of hydrologic and hydraulic data. The designer should inspect the site to verify natural drainage patterns, drainage areas, general soil characteristics and off-site factors.

The base data should reflect such characteristics as:

- land slopes,
- natural drainage patterns,
- unstable stream reaches and flood marks,
- watershed areas,
- existing vegetation (noting special vegetative associations),
- critical areas such as steep slopes, eroding areas, rock outcroppings and seepage zones,
- unique or noteworthy landscape values to protect,
- adjacent land uses — especially areas sensitive to sedimentation or flooding, and
- critical or highly erodible soils that should be left undisturbed.

6.6 References

Arizona Department of Transportation, Intermodal Transportation Division, Erosion and Pollution Control Manual for Highway Design and Construction

American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets. 1994.

American Association of State Highway and Transportation Officials, Guideline Volume III, Erosion and Sediment Control in Highway Construction.

U.S. Department of Interior, Bureau of Reclamation, Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25.

U.S. Department of Transportation, Federal Highway Administration, Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15. 1975.

U.S. Department of Transportation, Federal Highway Administration, Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14.